Topographic Maps & Contour Lines

Part 5 in a Series by ***Douglas A. Smith***
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A **topographic map** (graphic of the topography) is a two-dimensional map designed to depict a third dimension, i.e. height. It has a variety of uses that include identifying geographical features, measuring slope, planning routes, as well as general use you would receive from a basic highway map. It is frequently called a "topo" map.

A map is a graphic representation of a portion of the earth's surface as seen from above and is usually drawn to scale. A major feature of a topo map is the **contour line**. It is a line on a map that represents equal vertical elevation, above mean sea level, at any point along the line. Since each line is equal elevation, it is impossible for lines to cross.

The most common place to find contour lines is on a U.S. Geographical Survey (USGS) or Military Topographic Map. The standard color for a contour line is brown. Starting at zero elevation, every fifth line is heavier. These heavy lines are called *index lines* and each has the elevation written on them. Lines between the index lines are called *intermediate lines* and give additional shape to the map. Figure 1 depicts an index line at both 500 and 600 feet. The intermediate lines are interpolated as 520, 540, 560 and 580 feet. The map legend will indicate the contour interval for the vertical distance between lines.

Let's begin our journey into topography by introducing **slope**, the relationship between vertical and horizontal distance.

Figure 1 - Contour lines.

When contour lines are close together, that means that there is a steep rise or fall in the terrain. See Figure 2a. When lines are relatively far apart, that indicates generally flat terrain. See Figure 2b.

A closer look at slope presents two possibilities. A slope may be convex or concave. Contour lines showing a concave slope will be closely spaced at the top of the feature and widely spaced at the bottom. See Figure 3a. The convex slope will be just the opposite; contour lines will be widely spaced at the top and closely spaced nearer the bottom. See Figure 3b. Understanding this relationship and recognizing it on a map might cause the traveler to choose one path over another.

Now that we recognize steep and relatively gentle sloping terrain, how can we determine an average percent slope over an identified straight path? To do this, make a point on your map. Draw a straight line to another point. Measure the length of the line and determine the ground distance by using the map scale. Now determine the elevation of both ends of the line. The remainder is a mathematical computation. Divide the difference in elevation by the horizontal distance and multiply the answer by 100. This produces the average percent slope between your two points. See Figure 4. (Be sure to use the same units of measurement for both the vertical and horizontal distance.)

Figure 2a - Uniformly steep slope.

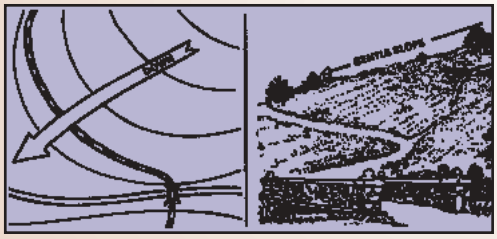

Figure 2b - Uniformly gentle slope.

Figure 3a - Concave slope.

Figure 3b - Convex slope.

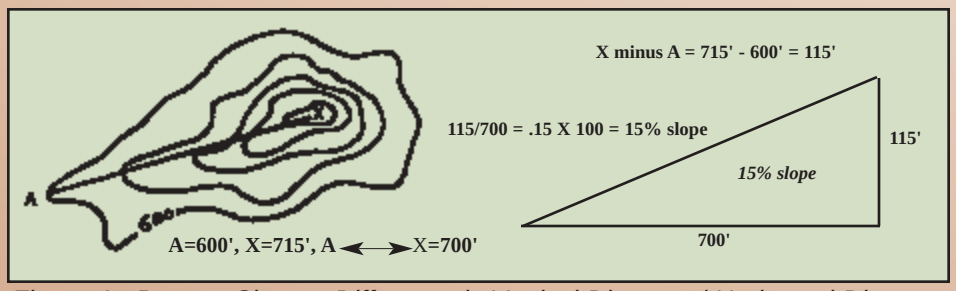

Figure 4 - Percent Slope = Difference in Vertical Distance / Horizontal Distance X 100. Percent Slope is an expression of the number of feet of rise or fall per 100 feet of linear distance and is not a degree of angle.

Figure 5 - Hill with uniformly gentle slope.

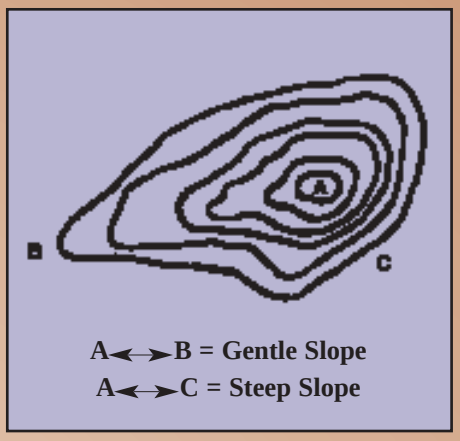

Figure 6 - Hill with varying slope.

As we continue our journey into contour lines, we learn there are five major topographic features: the **hill, saddle, ridge, valley,** and **depression**. Each has value, depending upon the need of the user and each will be depicted along with an explanation.

Let's begin with the **hill**, which is an area of high ground. From the top of a hill, the ground slopes downward in all directions from the top. It may have a gentle or steep slope in any given direction. Figure 5 depicts a hill with a relatively uniform slope in all directions. The smallest circle is near the top. The "X" marks the highest point past the last contour line. (This point is often excluded on maps.)

Figure 6 depicts a hill with one side having widely spaced contour lines and the other side with closely spaced lines. This means that one side of the hill is a gentle slope and the other side is steep.

A **saddle** is a dip or low point between two areas of higher ground. If you are in a saddle, there is high ground in two opposite directions and lower ground in the other two directions. A saddle is normally represented as an hourglass. See Figure 7. When traveling through hilly terrain, the traveler would probably choose to cross at the saddle instead of going over the top of either hill.

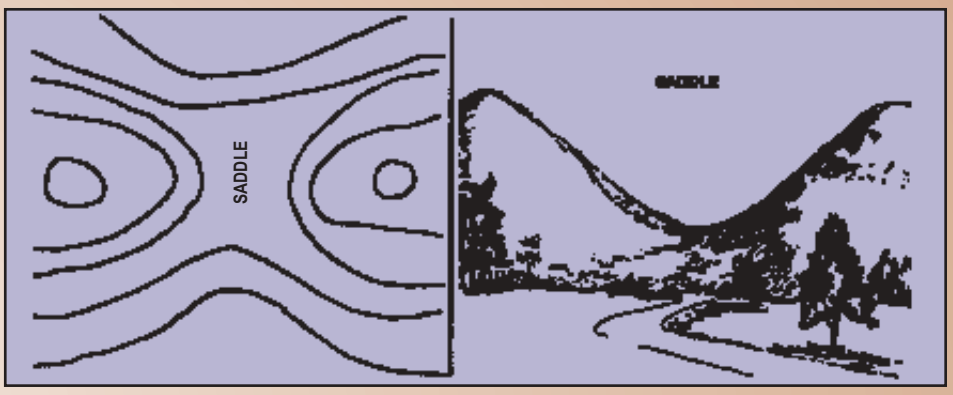

Figure 7 - Saddle.

If a hill can be seen to rise above the terrain, a **depression** can be described as going below the surrounding terrain. A more exact description is an area from which you see higher ground in all directions. One example of a depression would be a mining pit. If the depression is shallow, there are "tick marks" on the map indicating everything inside the marked circle/contour line is a hole. See Figure 8a. If the depression is deep, there are tick marks and contour lines within the depression indicating the depth of the depression. See Figure 8b.

A **ridge** is a fairly long, narrow piece of terrain extending away from a hill. Think through this mental picture. When standing on a ridge, you are looking downhill in three directions (down the length of the ridge and down on either side) and uphill in one direction. Notice in Figure 9 that the "U" shaped contour

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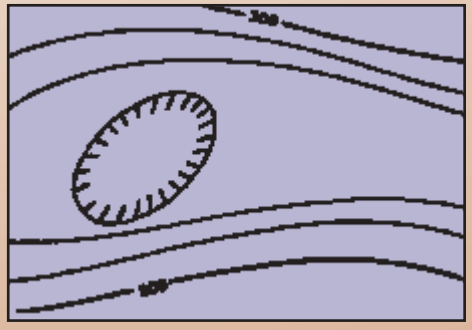

Figure 8a - Shallow depression.

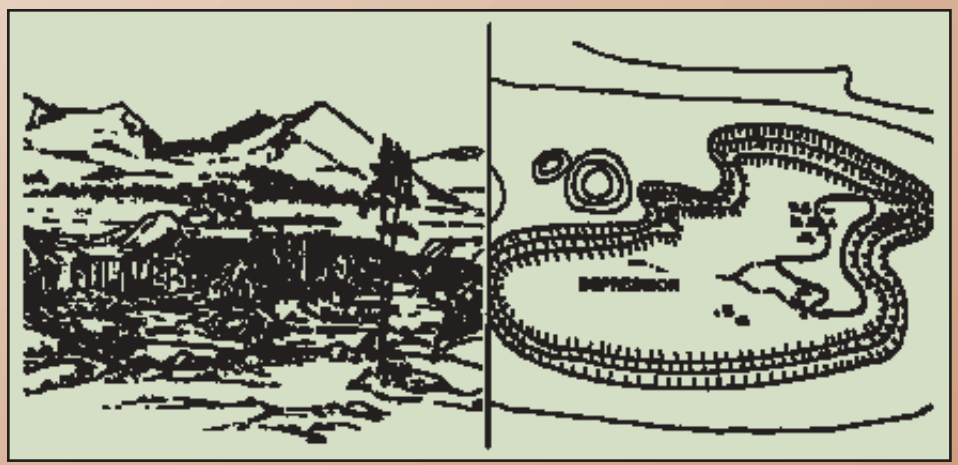

Figure 8b - Deep depression.

Figure 9 - Ridge.

Figure 10 - Ridgeline.

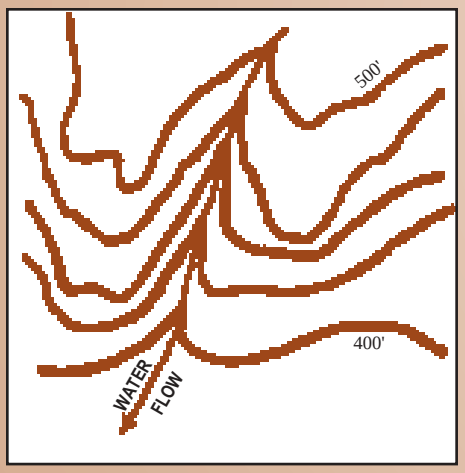

Figure 11 - Contours and water flow.

lines point downhill or down ridge. If a short, similar feature juts from a ridge, it is called a **spur** (Figure 13). A spur is classified as a minor terrain feature. The term ridgeline (Figure 10) is not interchangeable with the term ridge, and a ridgeline is not a major or minor terrain feature. A ridgeline is a line following the highest points along a series of terrain features.

If the "U's" point downhill on a ridge, what happens to contour lines when they cross a stream? Since contour lines must stay at the same elevation, they cannot drop down into the stream bottom. They must continue upstream until that elevation requirement is met.

This produces a "V" shaped graphic. Notice that contour lines always point upstream, or water in the stream flows in the direction opposite the point of the lines. See Figure 11.

Now that you know more about contour lines, elevation, and slope, think about the question: Do rivers flow from north to south or south to north? The most common flow in the U.S. is north to south (one exception is the St. Johns River in Florida which flows north). However, the answer is that water flows from a higher point towards a lower point. That might be any direction for any given segment of the flow. Ask your friends and evaluate their response.

The **valley** is the last of the five major terrain features to be explained. A valley is a stretched-out groove in the land, usually formed by water flow. When standing in a valley, you would see high ground in three directions and low ground in one direction.

Valleys take on a variety of shapes. In Figure 12, the bottom of the valley (lowest point between the sides of the valley) has a water flow that empties into a bay. There are many other variations, but remember that a detailed view of contour lines at the water flow will look like Figure 11.

An understanding of contour lines lets you look at a topo map and get a general feel for the shape of the land on the entire map. Another aid to getting a feel for the entire map is color. Always look at your map legend, but the standard is *brown* = contour lines, *green* = vegetation, *blue* = water, *black* = roads, and *red and black* = man-made features such as roads, buildings, urban areas, railroads, and boundaries. Synthesize topography and color and impress your friends with your ability to quickly describe the real world depicted by a topographic map.

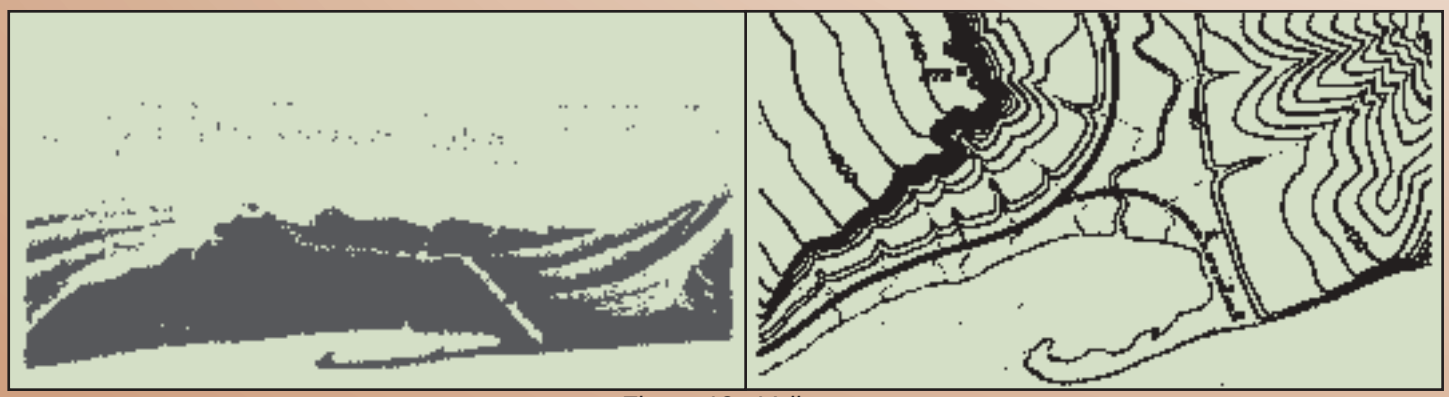

Figure 12 - Valley.

Figure 13 - Spur and draw.

Figure 14 - Cliff.

Figure 15 - Cut and fill.

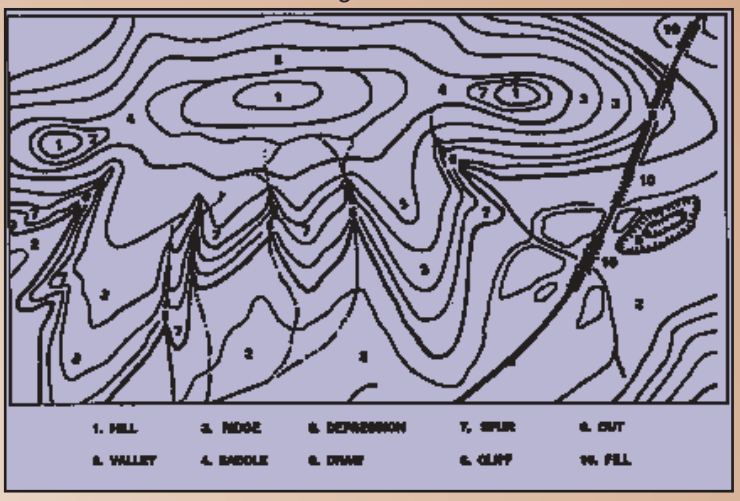

Figure 16 - Terrain features.

The five major terrain features have been previously presented. Now, the five minor/supplementary terrain features will receive a brief mention. They are the **draw, spur, cliff,** and **cut** and **fill**. The **draw**, a mini version of the valley, and the **spur** are depicted in Figure 13.

Figure 14 depicts a **cliff**, a vertical or near-vertical feature. It is an abrupt and potentially dangerous change in the terrain. It shows that the slope is so steep for a cliff, that accordingly the contour lines are close together enough to merge into one line.

Cut and fill are features not commonly used to navigate. However, they are discussed and shown since you may see them on a map and wonder what they mean. A **cut** is a man-made feature resulting from cutting through raised ground. This is usually done to form a relatively level bed for a road or railroad track. Graphics show tick marks that extend from the cut line to the roadbed, similar to a depression. **Fill** is just the opposite. Fill is a man-made feature resulting from filling in a low area. Tick marks point towards lower ground. See both cut and fill in Figure 15.

Figure 16 is a graphic that includes all ten features discussed here and in previous articles. Test your memory and try to identify them before looking at the answers.

Most graphics were previously published by the USGS or military.

Topographic Maps and Southern Pine Beetle Detection

The use of topographic maps is an essential part of the Southern Pine Beetle (SPB) detection surveys. The observers in an aircraft mark the location of active SPB infestations using a Global Positioning System (GPS). This GPS data is then put on a topographic map. The map is sent to the landowner whose trees are infested. Using the information in the "Contour Lines and Topographic Map" article, the landowner should be able to find the SPB infestation on the ground and begin control measures. (See example of a topographic map with an SPB infestation denoted.)